SECTION 233625

AIRFLOW CONTROL SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

A. Division 01 General and Special Conditions.

1. Section 01 33 00 – Submittal Requirements.

B. Division 23 00 00 HEATING, VENTILATING AND AIR CONDITIONING (HVAC).

1. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT: Procedures and requirements for managing and disposing construction and demolition waste.

2. Section 01 81 11, SUSTAINABLE DESIGN REQUIREMENTS: Sustainable design requirements including submittal requirements.

3. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS: Requirements for commissioning, systems readiness checklists, and training.

4. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

5. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

6. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

7. Section 23 31 00, – HVAC DUCTS AND CASINGS.

8. Section 23 36 00, AIR TERMINAL UNITS.

9. Section 23 82 16, AIR COILS (REHEAT COILS).

1.2 SCOPE

A. Scope Details:

1. For areas indicated as requiring pressure control, furnish and install an Airflow Control System (ACS/BAS) in conjunction with the central Building Automation System (BAS) Section 23 09 23 to maintain room supply and exhaust airflows, room ventilation rates, room static pressurization, room ambient temperatures & humidity's and the associated exhaust system functionality as specified herein

~~2. The ACS/BAS shall ensure that all VAV fume hood average face velocities and minimum exhaust airflows are maintained as indicated in the project plan schedules.~~ (Add.No.01)

~~3.~~2. The ACS/BAS shall ensure that all CAV fume hood exhaust airflows are maintained as indicated in the project plan schedules.

~~4.~~3. The ACS/BAS shall ensure that all biological safety cabinets and/or other required exhaust airflows listed in the project plan schedules are maintained.

~~5.~~4. The ACS/BAS shall provide the laboratory emergency control modes as detailed in this specification.

~~6.~~5. The ACS/BAS shall comply with the functional requirements of U.S. OSHA 29 CFR, (Canada Public Works MD 1580), NFPA 45, ANSI Z9.5, and all applicable Local and State (Provincial) codes

~~7.~~6. All Building Controllers shall directly reside on the primary BACnet/IP Ethernet network such that communications may be executed directly between Building Controllers, directly between server and Building Controllers on a peer-to-peer basis. All secondary network controllers shall communicate via BACnet MS/TP protocol. All controllers shall comply with ANSI/ASHRAE 135-2010 BACNet: A Data Communication Protocol for Building Automation and Control Networks.

~~8.~~7. The ACS/BAS shall be a direct extension of the existing campus BAS System, Siemens Apogee. Integration shall provide for a fully functional single database system and graphic driven operation and reporting tools from the existing VAPAHCS BAS network. Desktop link/ hyperlink or application launch to independent operator interface for 3rd party systems shall not be acceptable.

B. The ACS/BAS shall include all laboratory, vivarium, isolation or critical room supply and exhaust airflow terminals, reheat coils, reheat coil valves, air terminal actuators, sensors, associated instrumentation and the control units and associated interconnecting wiring and pneumatic tubing. Any and all associated components required to implement a fully functioning and integrated system as specified herein shall also be provided. System verification and other documentation as specified under the commissioning plan section shall also be included.

C. All ACS/BAS data shall be capable of being accessed by authorized persons via the facility BAS network as well as via the Intranet using standard web browsers to obtain ACS/BAS data in graphical form as well as in specific user defined and configured ACS/BAS summary and status reports.

1.3 QUALITY ASSURANCE REQUIREMENTS

A. ACS/BAS components shall be the standard catalogued products of the ACS/BAS supplier and shall be the most recent product design that complies with the specified requirements.

B. The manufacturer of the ACS/BAS shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

C. The ACS/BAS supplier shall have a fully staffed support facility within 50 miles of the project site with fully qualified, factory trained technical support personnel, spare parts and all necessary test, diagnostic and service equipment.

D. The complete installation of the ACS/BAS shall be the responsibility of the ACS/BAS supplier and the checkout, startup and verification of specified performance of the ACS/BAS shall be by factory trained employees of the ACS/BAS supplier.

E. Provide UL 864 – UUKL Smoke Control, where controllers and networks are used for that purpose.

F. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

1.4 SUBMITTAL REQUIREMENTS

A. Refer to Division 01 - Submittal Procedures.

B. The submittal documentation shall include:

1. Manufacturer’s product data sheets including technical specifications of all ACS/BAS components including air terminals, sensors, actuators, reheat valves, control units, local monitors, etc. Where applicable the specifications shall include minimum and maximum flow rates, sound ratings, measurement device accuracies, operational ranges, etc.

2. A tabulation of all air terminals including types, sizes, air capacities, sound ratings, reheat coil ratings, etc.

3. A comprehensive list of all ACS/BAS input/output functions including all alarm and monitoring points.

4. Detailed descriptions of all ACS/BAS operational sequences.

5. Shop drawings showing ACS/BAS control unit configuration and wiring connection diagrams covering all ACS/BAS input/output interconnections and termination details.

6. Electrical characteristics indicating any field wiring which is to be performed by others, type of signal wiring, and installation methods including raceway type and grounding method.

7. Control drawings with graphic representation of system components. Identify controlled devices as referenced on plans with unique valve and damper tag numbers.

C. Organize submittal with table of contents and tabs for each section arranged by logical groups of devices.

D. Provide submittals for fast track items that need to be approved and released to meet the schedule of the project separately.

E. LEED Submittals: Submit in accordance with Section 01 81 11.

1. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

2. LEED Product Data Submittal Form: Submit completed product data form provided by the Contracting Officer's Representative; certified by vendor, installer, subcontractor, and/or manufacturer as appropriate.

1.5 O&M MANUALS

A. Refer to Division 01 - General Requirements.

B. Operating and maintenance manuals shall provide descriptions of maintenance on all system components including sensors and controlled devices. These shall include Control Contractor’s completion check list, inspection requirements, periodic preventative maintenance, cleaning methods and materials, troubleshooting guide, calibration instructions and tolerances, repair parts lists, and manufacturer representative’s name, address, and phone number.

C. O&M Manuals shall also include interconnection wiring diagrams with identified and numbered system components and devices.

1.6 RECORD DRAWINGS

A. Refer to Division 01 - General Requirements.

B. Submit revised shop drawings indicating all changes made during project including any changes to operating sequences or setpoints.

C. Update control diagrams to include all tuning parameters and setpoints applicable to systems as depicted as of date of system completion. This information shall be incorporated with sequence of operation of each system.

D. Record actual locations of control components including control units, temperature/humidity sensors, air terminals and any controlled devices on As-Built ductwork/piping plans provided by Mechanical Contractor

1.7 WARRANTY

A. The Contractor shall warranty the ACS/BAS to be free from defects in workmanship and material for a period of one (1) year from the date of acceptance by the Owner. During the warranty period, the Contractor shall furnish all labor to repair or replace all items or components that fail due to defects in workmanship or material. This contractor shall also provide all system software upgrades during the warranty period.

B. The Contractor shall provide an on-line troubleshooting service during the warranty period. The on-line system shall allow the contractor or owner’s agent the ability to interrogate, troubleshoot and correct warranty defects remotely. This system shall be operational 24 hours a day, 365 days a year. If the local manufacturer’s staff cannot

resolve the problem, the corporate home office staff shall remotely connect to the system and troubleshoot the warranty defect.

C. The Contractor shall submit a written report within 3 days of all warranty defects, the action taken, and corrections made for each warranty call.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The following are approved ACS/BAS manufacturers and product lines:

1. Siemens – Apogee or equal.

2. No known equal.

B. The ACS/BAS shall be a completely digital system, with electric actuation, manufactured and provided by a single manufacturer.

2.2 GENERAL

A. Materials shall be new, unused and free from defects and imperfections.

B. The ACS/BAS shall be stand-alone for each individual laboratory or laboratory support space. System shall not use or rely on information from controllers in other laboratory areas or from outside laboratory space to control functions within its laboratory.

C. Unless indicated elsewhere herein, the lab airflow control system shall use volumetric offset to maintain room pressurization. Offset airflow requirement is indicated for each lab on Air Terminal Device schedule.

D. Control wiring shall meet requirements of specification of the Building Automation System.

E. Control panels shall be located near entry to each lab or mounted on air terminal(s) serving space. Coordinate location of control panel with all trades to provide access to panel for maintenance. Provide communications jack as part of or adjacent to space temperature sensor to allow communication between laptop computer and control panel. Provide one control panel for each area or suite as indicated.

2.3 AIR TERMINAL DEVICES

Supply Terminal Casing Leakage (CFM)						
	Casing Leakage			**Damper Leakage**		
Unit Size	1.0″ wc	3.0″ wc	6.0″ wc	1.5″ wc	3.0″ wc	6.0″ wc
4	1	2	3	4	5	6
6	1	2	3	4	6	11
8	1	2	3	5	7	10
10	1	2	3	6	7	10

12	1	2	4	8	12	19
14	2	3	5	6	10	16
16	2	4	7	13	21	38
18	3	6	12	98	154	305

Exhaust Terminal Casing Leakage (CFM)							
Unit Size	**1" WC**	**3.0"WC**	**6.0"WC**	**Unit Size**	**1.0" WC**	**3.0" WC**	**6.0"WC**
4	0	1	3	10	1	3	4
6	0	1	3	11 / 12	1	2	3
7	1	2	4	14	1	3	5
8	1	2	4	16	1	3	5
9	1	2	4	18	1	3	5

Closed Blade Leakage, No Seals (Per ASHRAE 130-1996)							
Imperial Units (CFM, Inches Water)							
Unit Size	**1.0" WC**	**3.0"WC**	**6.0"WC**	**Unit Size**	**1.0" WC**	**3.0" WC**	**6.0"WC**
4	13	20	25	10	67	110	135
6	31	50	63	11/12	72	144	168
7	39	58	77	14	98	195	228
8	42	73	94	16	133	266	310
9	56	94	111	18	112	280	335

Blade Seal Leakage (VOLARA; Per ASHRAE 130-1996)							
Imperial Units (CFM, Inches Water)							
Unit Size	**1.0" WC**	**3.0"WC**	**6.0"WC**	**Unit Size**	**1.0" WC**	**3.0" WC**	**6.0"WC**
4	0	1	3	10	1	3	4
6	0	1	3	11/12	1	2	4
7	1	2	3	14	1	3	5
8	1	2	3	16	1	3	5
9	1	2	4	18	1	3	5

A. ZCU – ZONE CONTROL UNIT

1. Provide Siemens ZCU or approved equal for supply terminals serving spaces as indicated on schedule sheet.

2. The ZCU manufacturer shall be a Company specializing in manufacturing the ZCU specified in this Section with a minimum four years documented experience.

3. Furnish and install a fully catalogued Modular Zone Control Unit (ZCU) with integral pre-programmed controls, reheat coil, sensors and piping accessories of the sizes and capacities as scheduled. Units shall be manufactured by SIEMENS or equal. The ZCU's shall be UL-916 listed.

4. Prior to submittal review, the ZCU manufacturer shall supply a letter signed by an officer of the Company stating the ZCU's proposed do not infringe on current patents.

5. All integral appurtenances of the ZCU, including the piping and controls, shall be manufactured by the same manufacturer of the ZCU. All testing, commissioning programming, certification and validation of the ZCU shall be performed by the same ZCU manufacturer. All electrical components including low voltage and line voltage components and wiring shall be completed by the same ZCU manufacturer and mounted and wired in an electrical enclosure. Units shall have a single point field wiring connection and disconnect. Units shall be manufactured and wired per UL-1995 and in accordance with the National Electric code.

6. The ZCU manufacturer shall provide a 2 year parts and labor warranty for the complete ZCU including all the integral appurtenances.

7. The contractor shall furnish and install pressure independent single duct variable air volume control assemblies with integral attenuator of the sizes, capacities and configurations shown on the Drawings.

   a. Terminals shall be constructed of not less than 22 gauge galvanized steel with a minimum G60 zinc coating, able to withstand a 125 hour salt spray test per ASTM B-117. Stainless steel casings, or galvanized steel casings with a baked enamel paint finish, may be used as an alternative. Air Terminals shall be certified under ARI standard 885-98. Terminal units shall be either UL or ETL certified. All electrical components including low voltage and line voltage shall be mounted and wired in an electrical enclosure.

   b. Air terminal shall be insulated with 1 inch thick, 1.5 lbs/cubic foot Thermopure – (EPFI) Engineered Polymer Foam Insulation liner, rated to prevent air flow erosion to 6000 fpm surface velocity. The insulation shall comply with UL 181 and NFPA 255 (25/50). Material shall be chemically resistant to most hydrocarbon based solvents. Material shall not support mold

growth or demonstrated degradation while subject to air erosion when tested in accordance with UL 181 and UMC 10-1.2.

c. All interior features of the boxes (such as mixing baffles, damper housings, etc.) shall be secured within the casing to avoid excessive movement or rattling with air movement or extremely generated vibration.

d. 12 gauge universal handle brackets shall be installed on the vav box unit casing stiffening up the 22 gauge vav unit casing, lowering radiated noise, connecting the integral appurtenances and allowing the installing tradesman a location for material handling of the ZCU without damaging it.

e. The discharge connection shall include 1″ extension with slip and drive connections for use by the contractor to secure the discharge ductwork or appurtenances to the unit and shall be reinforced to provide a rigid assembly.

8. Inlet valve assembly shall have a seamless butt weld on a round inlet tube to minimize leakage and prevent the damper from binding. Inlet tubes with overlapping welds or non-continuous, skip welds are not acceptable. Damper shaft shall rotate in a self-lubricating Kepital (acetal resin material) bearing. Damper shaft shall be die cast aluminum. Damper shaft end shall include a casted damper position indicator. End of the shaft on which the damper actuator is installed shall be square to prevent actuator tightening screw(s) from slipping. Round damper shafts are not acceptable.

   Damper tube shall be free of obstructions including damper stops to allow the free rotation of the damper. Mechanical damper stops located in the inlet tubes are not acceptable. A flexible split partitioned gasket mounted in the damper blade without adhesives shall provide the damper seal. Damper gasket shall include split partitioning around the perimeter to prevent damper noise at low flows near full close off. Damper gaskets without perimeter split partitioning are not acceptable. Damper shall be double thickness of 24 gauge steel and leakage through the damper assembly shall be less than 1% of maximum CFM at 3″ static pressure.

   Inlet air valve shall have structural beads machine formed into the tube. One external bead shall be provided for the attachment of duct.

   Inlet air valve flow sensor shall be multipoint quadrant averaging with flow sampling of both velocity pressure and flow differential pressure from four quadrants, and shall contain two control ports and two accessory ports. Flow sensors sampling only velocity pressure in all four quadrants are not acceptable. Sensors reading differential pressure with less than 8 measuring points are not acceptable. All piping connections to the flow sensor must be made with external ports that extend through the damper tube. Units with piping connections made in the primary air stream are not acceptable. Flow sensors with plastic piping connections of any kind are not acceptable.

9. Damper leakage: The following is the maximum damper leakage allowable for the various size diameter inlets at 6 inches wg differential pressure. The damper leakage shall not exceed the values listed in the table below at 6 inches S.P.,

Diameter	Maximum Allowable Allowed CFM (Area x 2000 fpm)	CFM Damper Leakage
4″-6″	393	6.0
7″-8″	698	10.5
9″-10″	1091	16.5
11″-12″	1571	20
13″-14″	2138	30

10. Casing leakage: Assembled units shall be so constructed and sealed to limit air leakage to the following listed quantities at 6 inches static pressure. The following is the maximum allowable casing leakage including all components including the heating coil:

Diameter	Maximum Allowable Allowed CFM (Area x 2000 fpm)	CFM Casing Leakage
4″-6″	393	8.0
7″-8″	698	14
9″-10″	1091	22
11″-12″	1571	30
13″-14″	2138	40

11. Access plenum and door: Single duct units provided with hot water coils shall be provided with an access section downstream of the coil for coil inspection. The construction of the plenum shall be equal to the quality of materials and workmanship to that of the terminal unit. The access plenum shall contain a minimum of an 8 inch diameter or 8 inch by 8 inch access door. (Add. No.1) Door frame may be bolted, sealed or flanged to the casing. The door shall be gasketed and insulated double wall construction. Door shall be held in place with latches or other captive retainer devices. On single duct and double duct boxes, an additional access panel shall be provided immediately upstream of the dampers for inspection and service of the dampers.

12. Sound attenuator: (provide where indicated on schedule sheet). A factory supplied 24 inch sound attenuator shall be supplied downstream of the coil. The ZCU shall ship with the sound attenuator attached to the coil. The attenuator and coil connection shall be sealed with a hard cast sealant and tape. The construction of the sound attenuator shall be equal to the quality of materials and workmanship to that of the terminal unit.

13. Unit pressure drop: The static pressure across the assembly with an equivalent 2000 fpm inlet velocity through one inlet shall not exceed .05 inches water gauge, with the total flow through either inlet.

14. Controls enclosure: A controls panel with a sliding controls cover shall be supplied. The controls cover shall reside in a set position without the use of any mechanical fasteners or screws. “Quick release” sheet metal tabs/guide stops shall be supplied to keep the cover from slipping off when in the fully open position. The “quick release” tabs/guide stops shall be designed in such a way to allow the complete removal of the cover. A handle shall be supplied on the controls cover for opening and closing the controls cover. Control panels without a sliding enclosure, handle and “quick release” tabs are not acceptable. All electrical and electronic components including both line voltage and low voltage shall be mounted in the metal controls enclosure per applicable codes. Units shall have a single point wiring connection. Units shall be manufactured and wired per UL-1995 and in accordance with the National Electric Code The control panel shall include stand-offs to allow mounting of controls without penetrating the casing.

15. Sound:

    a. Discharge sound per the schedule.

    b. Radiated sound per the schedule.

16. Hot water coils: hot water coils shall be factory installed one or two row with a maximum of 10 aluminum fins per inch. Air pressure drop shall be limited to 0.2” wg at box rated coil airflow. Full fin collars shall be provided for accurate fin spacing and maximum fin-to-tube contact. Aluminum fins shall be a minimum thickness of .0060 inch. Tubes shall be ½ inch diameter seamless copper with a minimum wall thickness of 0.025 inch, tested at 300 psig air pressure under water with a minimum rated burst pressure of 1500 psig. Side and plates shall be a minimum 20 gauge galvanized sheet metal construction. All coils shall be constructed and tested in accordance with ul and/or ari standards. Coils not meeting the minimum thickness specified are not acceptable and shall be rejected due to galvanic corrosion and the increased probability of leaks with the thinner wall thicknesses. Copper tubes greater than .025 inch tube wall thickness are not acceptable as the thicker copper wall thickness acts as an insulator. Slip and drive connections between the coil and the vav box shall be sealed with hard cast sealant and tape.

17. Adjustable universal handle brackets: a minimum of two adjustable universal handle brackets with built in handles shall be supplied for every ZCU furnished. Handles shall be constructed with a minimum of 12 gauge metal and painted using an electrostatic powder coating system to avoid corrosion. Handle opening shall be able to accept a minimum of the following lifting devices through the handle portion of the bracket without damaging the product including: human hand, forklift, unistrut, pipe or other lifting devices. The handle must

have a 180 degree – “rolled up edge” to prevent injury to the human hand: raw edges or non-rolled edges shall not be accepted.

18. Use a minimum of 4 military grade rubber grommets for elimination of galvanic corrosion and isolation between copper piping and support handles. The rubber grommets shall be made of a standard nitrile also known as buna-n and has excellent resistance to petroleum-based oils and fuels, water and alcohols. Nitrile also has good resistance to acids and bases, except those with a strong oxidizing effect.

19. Modular portable piping assembly: manufacturer shall assemble the piping assemblies to the universal handle brackets and the re-heat coils as one assembly integral to the ZCU. The entire unit shall be catalogued and have o & m manuals for the entire ZCU including the integral piping. All portable piping assemblies for the ZCU’s supplied shall be identical and interchangeable for inlet sizes of 4 inch through 22 inch. The supply and return aspect ratios shall be identical for all ZCU’s supplied. All components supplied shall carry a minimum of a 2 year parts and labor warranty from the manufacturer. Mechanical contractor shall provide this documentation at bid time. Products without this documentation are not acceptable. Field or shop assemblies of these components by a mechanical contractor are not acceptable.

20. Valve components: the following minimum piping components shall be supplied: with the minimum components: a valve package consisting of the following items: ball valve with a #20 stainless steel screen to act as a strainer, union, p/t port, drain or blow-down with ball valve integrated ¾” male garden hose end connection with a durable plastic retainer and brass cap. Pressure dependent balancing valve with an isolation valve, union, and pressure temperature readout ports, corrosion free brass manual air vent piped in at the highest point of piping to ensure excellent drainage and air removal from the coil, union with p/t port. Piped in Siemens atc control valve with Siemens actuator with two p/t ports and shut off valve with memory stop. Minimum 2” diameter pressure gauge rated at 1250 psig burst pressure to confirm 100% leak free product delivery. Type “l” 3/4” copper pipe.

21. Pressure independent dynamic control valve flow regulation unit

22. Valve shall be an electronic, dynamic, modulating, 2-way, pressure independent control device. A pressure independent dynamic control valve shall accurately control flow, independent of system pressure fluctuation. Maximum flow setting shall be adjustable to 41 different settings within the range of the valve size. Flow regulation unit shall consist of glass-reinforced polyphenylenesulfide with a hydrogenated acrylonitrile butadiene rubber diaphragm. Flow regulation unit shall be readily accessible, for change-out or maintenance.

23. A combination of a single flow control and control valve in one cartridge shall produce in excess of 99.00 % accuracy of design flow. Flow regulation unit shall be externally adjustable to 1 of 41 different flow rates; minimum range shall be capable of being

activated by minimum 4.4 psi differential operation ranges; and shall be capable of controlling the flow within greatest of either +/-10% of controlled flow rate or+/- 2% of maximum flow rate. The Siemens actuator shall be installed over the dynamic control valve.

24. Pressure independent valve requiring changing out a cartridge or spring to achieve a specific gpm from a range of 0 – 5 gpm is not acceptable. Stainless steel cartridges are not acceptable due to dirt accumulation on the stainless steel.

25. Portable piping structure – after final assembly of the piping components, the valves shall be charged with a gas and “blown open” per the manufacturer’s specifications, the portable piping structure shall be charged with a gas at greater than sea level pressure at the assembly area; seal the gas in the piping structure: test the sealed piping structure for 24 hours to determine whether the gas stays within the portable piping structure or leaks from the portable piping structure; if the gas leaks from the portable piping structure, identify the leak, fix it and re-test. Upon verification of the portable piping structure having zero leakage of the gas, attach an identification tag to the portable piping structure including testing information and identification information of the piping structure. Transport the sealed and pressurized portable piping structure from the assembly location to the construction site; determining a pressure of the gas at the construction site: correlating a difference between the pressure of the gas within the portable piping structure at the assembly location and the pressure of the gas within the portable piping structure at the construction site with the identification information including the portable piping structure information included on the tag; and incorporating the portable piping structure into an hvac system if the difference between the pressure of the gas within the portable piping structure at the assembly location and the pressure of the gas within the portable piping structure at the construction site meets the specified standard ensuring no leaks. If product is defective upon delivery of ZCU, the contractor shall notify the manufacturer of the defect. Upon notice and proper verification, manufacturer shall have 3 weeks to fix defective product or replace it.

26. Electronic/electric components – all electrical components shall be tested and certified by the manufacturer of the ZCU. Upon completion of the wiring, installation and programming of the electrical components the following testing procedures shall be done at the factory prior to shipment:

27. Verify power to all electrical and electronic components.

28. Verify actuator settings by electronically stroking all actuators per the set program of the DDC controller.

29. Verify DDC program is running correctly.

30. Digital pictures and commissioning statements shall be taken to verify these testing procedures are being done at the factory ensuring a 100% defect free product leaving the factory.

31. DDC controls: for each vav the manufacturer shall provide and ship a control package consisting of a DDC electronic controller and room sensor, differential pressure transducer, an electric damper actuator and an electronic control valve. All components shall be furnished, mounted, piped and wired by the ZCU unit supplier. The ZCU manufacturer shall program the DDC controller and test the programs at the ZCU unit manufacturer's factory. The ZCU shall be powered up and the program tested including stroking of the actuators through a full cycle.

32. Coordinate with the bas contractor. If project is not using power trunks, an electrical switch box with a disconnect switch, 24 volt transformer and low voltage wiring shall be provided and mounted on the ZCU by the ZCU manufacturer. All relays required shall be installed and wired in the electrical box. A single point electrical connection shall be provided to the ZCU unit. Low voltage wire from the control valve to actuator to the DDC controller shall be wired in flexible conduit in accordance with ul-1995 and the national electric code.

33. Disconnect switch to be UL approved. (2) 30 foot twisted pair wire shall be supplied and pre-wired to the ZCU DDC electronic controller's com terminals by the ZCU terminal supplier. A 25 foot (minimum) communications wire shall be supplied and pre-wired to the ZCU DDC electronic controller's room sensor. Size cable as needed for each room application. All of the wiring and electrical switch boxes on ZCU's shall meet national electrical code requirements and ul-1995. All wiring shall be tested for conductivity and certified by the ZCU quality control inspector prior to shipment. If factory supplied, the room sensor shall be tested and certified by the quality control inspector prior to shipment and ship pre-wired to the terminal unit in the electrical enclosure.

B. VENTURI AIR VALVE – CLOSED LOOP

1. Air terminals shall consist of venturi type air valves with adequate operational maximum to minimum airflow turndown ratios to provide the full range of minimum to maximum airflows listed in the project airflow control schedules. Terminal airflow shall be pressure independently controlled using actual airflow measurement feedback as well as a static pressure compensation spring as an integral part of the control process.

2. ~~The venturi air valve shall be capable of achieving maximum to minimum airflow and vice-versa within 1 second.~~ (Add.No.01) Each venturi air valve shall be factory calibrated to provide a minimum airflow sensor measurement and control accuracy of +/- 5% of actual airflow over the published range. Airflow measurement accuracy and response time substantiation by a qualified independent test agency shall be included with the submittal documentation. The spring and cone assembly shall be pressure independent over a (0.3) to 3.0 inches wg drop across the terminal at rated airflows.

3. Ganged valves, for supply, general exhaust or fume hood exhaust shall include completely welded connections to factory supplied end plates. Tack welding and caulk are not acceptable.

4. Provide a means for low air flow alarm under low flow condition and high airflow alarm under high flow conditions at each supply, general and fume hood exhaust valve. This may consist of two independent flow pressure switches per valve indicating high and low flow conditions, or a single independent flow station per valve. All pressure switches, flow stations, and position feedback signals shall be made available to the BAS for monitoring for safety and energy purposes. Pressure switches shall meet the same drift requirements of airflow transmitters specified herein.

5. The room supply and room general exhaust airflow measurement stations shall be comprised of an averaging type of airflow sensor. The fume hood exhaust airflow measurement stations shall also be comprised of an averaging type of sensor such as an orifice ring which is not subject to clogging by an accumulation of particulate or chemical deposits or is likely to catch debris such as tissues.

6. Airflow transmitter shall be factory mounted on the venturi and shall include the necessary signal conditioning/transmitter instrumentation to provide an output proportional to the velocity pressure. Transmitter shall have an accuracy of at least +/- 0.5% of the transmitter range and a drift no greater than 0.5% full scale/year. Transmitters shall have an appropriate range and resolution for effectively measuring the required flows. High and low limits shall be fully adjustable.

7. Transmitters not meeting these drift requirements shall be provided with an auto-zero solenoid that connects to the air velocity pressure transducers’ inlet ports for enabling automatic periodic re-calibration to ensure drift-free airflow measurement. Automatic re-calibration shall occur at a minimum every 24 hours without airflow disruption

8. Manufacturers not providing autozero modules responsible for automatic self-calibration, without disruption of airflow to the space, nor meeting the specified tranmitter drift requirements, shall be responsible to provide on-site recalibration service. This recalibration service consists of each terminal to be manually recalibrated by the manufacturer’s technician on a quarterly basis to ensure stated accuracies are maintained. Provide this service in this contract throughout the warranty period. Include service contract pricing inclusive of this service as an attachment to the bid.

9. Room supply venturi air terminals shall be constructed with an aluminum body and cone. The cone control shaft, control arm, brackets, clips ,screws, nuts and all fittings within the air stream shall be of type 316 stainless steel. Room supply venturi air valve terminals shall be provided with an averaging pitot tube array type of airflow sensor located upstream from all other terminal components. Hot water reheat coils shall be comprised of copper tubing of 0.017" wall thickness and have heavy gauge sine wave coil fins for efficient heat transfer.

10. Room general exhaust venturi air valve terminals shall be industrial grade and constructed with an aluminum body and cone.

The cone control shaft, control arm, brackets, clips, screws, nuts and all fittings that are within the air stream shall be of type 316 stainless steel. Room general exhaust venturi air valve terminals shall be provided with an averaging pitot tube array type of airflow sensor or orifice ring, if subject to particulate deposits, located upstream from all other air terminal components.

11. All fume hood and biosafety cabinet (BSC) (Add.No.01) exhaust venturi air valve terminals shall be industrial grade and constructed with an aluminum body and cone and shall have a Hersite phenolic coating. The cone control shaft, control arm, brackets, clips, screws, nuts and all fittings that are within the air stream shall be of type 316 stainless steel. Fume hood and biosafety cabinet (BSC) (Add.No.01) exhaust venturi air valve terminals shall be provided with an orifice ring type of airflow sensor located upstream from all other terminal components. Airflow sensing techniques that are likely to become inoperative due to accumulation of particulate or chemical deposits or which can catch debris and obstruct exhaust airflow shall not be acceptable for fume hood and biosafety cabinet (BSC) (Add.No.01) exhaust applications. Unacceptable airflow measurement sensors for fume hood and biosafety cabinet (BSC) (Add.No.01) exhaust air terminals include pitot tubes and other devices that protrude into the center of the exhaust air stream.

12. All venturi air valves shall be factory calibrated to meet the specific airflow ranges indicated in the project airflow schedules. All venturi air valves shall also be factory tested to substantiate +/- 5% airflow control accuracy at the minimum and maximum rated airflow as well as at least ~~six~~ three (Add.No.01) intermediate airflows between the minimum and maximum. All calibration and pressure independent airflow measurements shall be obtained using certified NIST traceable airflow measurement instruments. Each venturi air valve shall be provided with an individual certificate that includes a valve tag number, serial number, model number, factory eight point calibration data, pressure independent airflow test data and the quality control inspection number. This information shall also be included with the as-built project documentation.

13. Discharge and radiated sound power level data shall be provided for each different size and type of air terminal as part of the submittal documentation. Sound power data shall be obtained in accordance with ANSI/ASHRAE 130-1995 Standard Methods of Testing for Rating Ducted Air Terminal Units, except that air terminal inlet velocity shall accommodate the inherent lower maximum rate of a venturi air terminals as compared to traditional blade damper type air terminals. Sound Power Data shall be presented in accordance with the ARI 880-98 Standard for Air Terminals with the addition of an inlet airflow rate of 1000 fpm and a 1.5"w.c. pressure drop. All sound data shall be obtained by a qualified, accredited and ARI approved testing laboratory.

14. Provide shutoff type venturi ~~where indicated in schedule sheet~~air valve at all exhausted Biological Safety Cabinets (BSC) to allow isolation of BSC when BSC is shut off.(Add.No.01)~~.~~

2.4 TERMINAL UNIT ELECTRIC ACTUATORS

A. All actuators shall be UL 873 or UL 60730 listed and manufactured under ISO 9002 and ISO 14000 procedures.

B. All actuators shall be direct coupled type that requires no connecting linkage and shall provide a means of manual override in the absence of power.

C. All actuators shall provide stall protection throughout the full range of rotation with an easily visible position indicator.

~~D. High speed electronic actuators.~~ (Add.No.01)

~~1. Basis of design: Siemens GNP/GAP Series.~~

~~2. Provide high speed actuators for all terminal units serving rooms with VAV fume hoods and other areas as indicated. This shall include supply, general exhaust and fume hood exhaust.~~

~~3. Performance shall be no less than 53 lb-in (16 Nm) with 90 degree stroke in 2 seconds.~~

~~4. Repositioning resolution shall be a minimum of 0.4%.~~

~~5. Actuators shall be fail-safe or fail-in-place as indicated on drawings and shall be direct coupled type that requires no connecting linkages. Feedback shall be standard on all models. Actuators shall be capable of performing all control signals (2-position, floating and modulating – 0 to 10Vdc and 4 to 20 mA)~~

~~6. Power consumption shall be no greater than 25VA~~. (Add.No.01)

~~E.~~D. Standard speed electronic actuators.

1. Basis of design: Siemens GDE/GMA/GLB Series.

2. Provide for all terminals not requiring high speed actuation. Actuators shall be fail-safe or fail in place as indicated on drawings.

3. Spring return actuators shall be capable of both clockwise and counterclockwise spring return fail-safe operation that returns the actuator to a fail-safe position in <15 seconds in response to a loss of power. Power consumption shall be no greater than 7VA.

4. Actuators shall use either floating control or analog control, as needed by the control application the secondary network.

2.5 ROOM LEVEL CONTROLLERS

A. General: All room level controllers shall communicate directly on the primary BAS building level Ethernet network or communicate over the secondary network via the BAS manufacturer’s standard protocol. Manufacturers providing controllers requiring gateways or protocol translators shall be responsible for all hardware and software interface devices as well as support labor to ensure proper

communication. Any communication issues between the room level controls and the BAS will require onsite support from the manufacturer/vendor of the room level controller until all communication issues are resolved. In addition the room level controller manufacturer/vendor shall be responsible for providing documentation indicating which software points inherent in their system will and will not be available to the BAS via gateway/translator, prior to the bid.

B. General: All room level controllers shall communicate directly on the primary BAS BACnet/IP Ethernet network (without gateways or protocol translators) or communicate over the secondary network via BACnet MS/TP protocol. Manufacturers providing controllers requiring gateways or protocol translators shall be responsible for all hardware and software interface devices as well as support labor to ensure proper communication. Any communication issues between the room level controls and the BAS will require onsite support from the manufacturer/vendor of the room level controller until all communication issues are resolved. In addition the manufacturer/vendor shall be responsible for providing documentation indicating which software points inherent in their system will and will not be available to the BAS via gateway/translator, prior to the bid.

C. VAV/CAV GENERAL LAB AND PRESSURIZED ROOM CONTROLLERS

1. Lab and pressurized room controllers shall provide closed loop pressure independent control of all laboratory room ventilation and ambient requirements. The room controller shall continuously monitor all the supply and auxiliary exhaust airflow devices including VAV fume hoods in the room.

2. Pressure control algorithm shall control supply and exhaust airflow devices in order to maintain a volumetric offset (either positive or negative). The offset shall be field adjustable and represents the volume of air which will enter (or exit) the room from the corridor or adjacent spaces. Offset shall be maintained regardless of any change in flow or static pressure. In particular, if the lead airflow device does not meet its setpoint, the controller shall adjust to recover room offset.

3. The controller shall be configurable through the BAS for either supply tracks exhaust (negative spaces) or exhaust tracks supply (positive spaces). In addition, the controllers shall be configurable to either track flow setpoints or actual measured airflows. In order to maximize pressure control reliability during compromised situations (ie actuator failure, insufficient duct static pressure), the controller shall automatically switch to flow tracking from setpoint tracking, if the lead device (supply or exhaust) fails to stay within (selectable, typically 3%) flow units of its own set point for (selectable, typically 5 minutes) period of time. Controllers relying on setpoint tracking only shall provide details of proposed alternative.

4. Unless specifically indicated within the Sequence of Operation, volumetric offset shall be the only acceptable means of controlling room pressurization. Systems that rely on differential pressure as

a means of control shall provide documentation that space pressurization can be maintained if fume hood sashes are changed at the same time a door to the space is opened.

5. Room ambient control (temperature, humidity etc.) and any other room control functions (lighting, IAQ etc.) shall be maintained by the controller as indicated in Sequence of Operation

6. All laboratory room controllers shall include all inputs and control outputs necessary to perform the specified control sequences. Each laboratory room controller shall operate as a standalone unit, performing its specified control responsibilities independently. All input point and control output point databases as well as the control programs shall be stored in non-volatile EEPROM, EPROM and PROM memory, or a minimum of 100-hour battery backup shall be provided.

7. Laboratory and Pressurized Room Controllers shall have available a SECURE MODE of operation, in which changes to any control parameter can only be made from designated terminals on BAS by authorized personnel, and not locally through the man-machine interface port.

8. Momentary or extended losses of power shall not change or affect any laboratory room controller setpoints or stored data. Upon resumption of power the controller shall resume full normal operation exactly as before without any need for manual intervention. Upon a power failure or operational failure within the controller, the air terminal shall automatically be positioned to the predetermined fully open or fully closed (failsafe) position as indicated on the air terminal schedules in the project plans=

9. All laboratory room controllers shall include the ability to accept a minimum of two dry contact closure inputs from an auxiliary source into the room control sequence for such purposes as occupied/unoccupied ventilation changeover, emergency mode sequences, etc.

10. Airflow tracking controllers shall be capable of having separate volumetric offset setpoints for occupied modes and unoccupied modes.

11. All laboratory and pressurized room controllers shall provide a general alarm output that may be used for auxiliary signaling or notification.

D. VIVARIUM CONTROLLERS

1. Vivarium controllers shall meet all the requirements of General Lab and Pressurized Room Controllers.

2. AALAC Trending Requirements:

   a. The following points shall be made available for trending and storage in the BAS temperature, airflow, ACPH, pressure and humidity from each of the holding rooms as indicated in, ~~Point Summary~~Control Drawings (Add.No.01).

3. The Data Management system shall provide the following client reporting functions to users, based on their access and privileges:

   a. Dynamically provide a menu of points and groups available to users for report creation. Restrict access to data records not available to specific users.

   b. Interactively create reports that can contain graphs, tables, bitmaps, textboxes, page numbers and date/time information.

   c. Format graphs by defining data points, axis, scales, line/bar colors, min/max limits, tick marks and legend.

   d. Format tables by defining data points, column summary calculations (min, max, avg, sum), Min/Max limits, column descriptors, colorization and fonts.

   e. Secure reports from view by others or make reports public for use by others.

   f. Schedule report to be automatically produced and sent to networked/local printers or electronic file.

   g. Store/Manage reports. Restrict access to authorize users.

   h. Use Windows user accounts to control access to functions.

   i. Provide exception reporting to identify conditions outside normal operating conditions.

   j. Color coded high/low values.

   k. Display indications for annotated or modified data.

   l. Provide relative reporting periods such as today, yesterday, month-to-date, year-to date, or custom.

   m. Provide portion of day reporting (Daily 8AM to 5PM, for Month to Date).

   n. Provide HTML based reports.

   o. Provide PDF based reports.

   p. Support Digital Signatures and Digital Certificates in Reports.

4. Microsoft Office Integration:

   a. The Data Management system shall include the following Microsoft Office Integration:

      1) Microsoft Excel Add-in to connect as a client application and retrieve data.

      2) Dynamically provide a menu of points and groups available to users for access via Excel. Restrict access to data records not available to specific users.

3) Allow users to retrieve data and launch Excel Graphic functions.

5. Custom Client Applications

a. The data management system shall include the following support for custom application development:

1) Documentation of the open application programming Interface's inputs, outputs and naming.

2) Provide sample code for API use.

3) Install ODBC drivers.

6. Web Based Reporting Application:

a. The Data Management System shall provide a graphical interface that allows users to access the stored data via the Internet, extranet, or Intranet. The interface shall use HTML based ASP pages to send and receive data from the data management system.

b. Access may be password protected. Users shall be able to configure reports and/or run reports.

c. The web-based interface shall provide the following functionality to users, based on their access and privilege rights:

1) Logon - Allows users to logon to the application.

2) Configuration Interface - Define groupings of data management system point for reporting. Define basic report formats for all predefined reports.

3) Report Generation Interface - A graphic selector list will allow users to select grouping of points, date range and report type to produce a report.

4) Daily Summary Reports – Report providing Min/Max/Avg values for each point grouping of Air Changes per Hour, Humidity and Temperature.

5) Lighting Reports – Graphical display of lighting status for a 24-hour period for multiple groups.

6) Environmental Reports - Tabular display of area temperature, humidity, pressure and lighting status.

2.6 SPECIALTY EXHAUST CONTROLLERS

A. General: All specialty exhaust controllers shall communicate over the secondary network via the BAS manufacturer's standard protocol. Manufacturers providing controllers requiring gateways or protocol translators shall be responsible for all hardware and software interface devices as well as support labor to ensure proper communication. Any communication issues between the specialty exhaust

controllers and the BAS will require onsite support from the manufacturer/vendor of the specialty exhaust controller until all communication issues are resolved. In addition the specialty exhaust controller manufacturer/vendor shall be responsible for providing documentation indicating which software points inherent in their system will and will not be available to the BAS via gateway/translator, prior to the bid.

B. General: All specialty exhaust controllers shall communicate over the secondary network via BACnet MS/TP protocol. Manufacturers providing controllers requiring gateways or protocol translators shall be responsible for all hardware and software interface devices as well as support labor to ensure proper communication. Any communication issues between the specialty exhaust controllers and the BAS will require onsite support from the manufacturer/vendor of the specialty exhaust controller until all communication issues are resolved In addition the manufacturer/vendor shall be responsible for providing documentation indicating which software points inherent in their system will and will not be available to the BAS via gateway/translator, prior to the bid.

C. Specialty exhaust controllers shall contain a start-up mode which allows the controller to be started up without a nuisance alarm being sounded at the hood. While in startup mode, the controller is fully operational, except the ODP only displays OFF and the red LED is ON. Alarms or failures are not displayed while in this mode of operation. This mode is most useful while the building is still under construction and the exhaust fans are being turned off

D. Specialty exhaust controller shall be provided with an “Out of Service” mode. During this mode, controller shall be is fully functional, except the flow setpoint is set to 0, alarming is limited and the ODP displays “Out of service” and “OFF”. If the sash is opened, nothing changes.

E. Any specialty exhaust controllers which do not communicate directly via BACnet MS/TP will be required to be identified in writing by the vendor/manufacturer for approval prior to bid. r: facility details = BACnet

~~F. VAV FUME HOOD FACE VELOCITY CONTROLLER~~ (Add.No.01)

~~1. Furnish and install a UL 916 listed individual VAV fume hood controller for each VAV fume hood which shall maintain the required average face velocity at the setpoint independently of the sash position. Documentation verifying the UL 916 Listing for the fume hood controller shall be included in any proposal as well as the submittal. Also, furnish and install sash sensors on each fume hood to indicate the position of all fume hood sashes to the respective fume hood controller. Sash sensors shall provide an input signal to the fume hood controller that is linearly proportional to within one half inch of the actual sash position. All sash sensors shall be highly corrosion resistant. Sash sensor operational life shall allow a minimum of 1 million full sash travel cycles.~~

~~2. The fume hood face velocity control process shall maintain the average fume hood face velocity at the desired setpoint using a~~

proportional, integral and derivative (PID) closed loop control algorithm. The fume hood face velocity control process shall be as follows:

a. The fume hood controller shall continually determine the fume hood's total open area by monitoring the fume hood sash position(s) by the sash sensor(s) as well as taking account of any fume hood fixed open areas and the bypass opening(s).

b. The fume hood controller shall calculate the required fume hood exhaust airflow necessary to maintain the average face velocity setpoint over the total open area. The controller shall continuously perform the above exhaust airflow control calculations ten times per second to ensure detection of and a maximum of 1 second response to any change in sash position.

c. The fume hood controller shall control the fume hood exhaust airflow at the rate necessary to maintain the average face velocity setpoint. The fume hood controller shall ensure that the required fume hood exhaust to maintain the average face velocity setpoint is always maintained independently of any variations in exhaust system static pressure or any laboratory room conditions such as the ventilation airflow or room static pressure that could otherwise affect the fume hood exhaust airflow.

d. The fume hood face velocity control process shall accommodate the required fume hood maximum to minimum exhaust airflow rate. The fume hood controller shall always maintain the required minimum fume hood exhaust airflow recommended by laboratory safety standards whenever the total fume hood open area requires less than the calculated fume hood exhaust airflow necessary to maintain the average face velocity set point. The fume hood controller shall also be capable of limiting the maximum fume hood exhaust airflow regardless of the extent of the sash opening.

3. The fume hood controller shall also interface to an Operator Display Panel (ODP) at the designated measurement location on the front of the fume hood as shown on the project plans. The ODP shall provide a continuous digital display of average fume hood face velocity whenever the fume hood sash open area requires more than the minimum fume hood exhaust airflow. The fume hood face velocity display shall be the true average face velocity as calculated by the fume hood controller based upon actual measured fume hood exhaust airflow and the total fume hood total open area. The Operator Display Panel shall have the ability to blank out display of face velocity based on owner’s preference.

4. The ODP shall also include separate colored pilot lights that shall illuminate to indicate fume hood operational status as:

a. Green for proper face velocity or flow.

b. Yellow for marginal face velocity or flow.

c. Red for alarm conditions such as low face velocity, general failure or emergency purge

d. The ODP shall also sound an audible alarm device in response to face velocity alarm conditions and the ODP digital display shall change to "LOW FACE VELOCITY" or "HIGH FACE VELOCITY" appropriate to the alarm condition. A SILENCE pushbutton on the ODP shall allow the user to silence the audible alarm which shall then remain silent until a subsequent alarm occurs.

e. The ODP shall also provide an EMERGENCY PURGE pushbutton which shall enable a user to increase fume hood exhaust airflow to the maximum amount for a designated period of time as required by laboratory safety standards. After the designated time has expired the fume hood exhaust shall automatically reset to a lower, but still elevated level to prevent excessive demand on the exhaust system. The emergency purge mode of operation shall also be able to be cancelled at any time by depressing the emergency purge button a second time. The ODP shall sound its audible alarm device whenever the emergency purge mode of operation is activated. The silence pushbutton on the ODP shall also allow the user to silence the audible alarm which shall then remain silent until either the emergency purge operational mode is again activated or a face velocity alarm occurs.

f. The ODP shall also provide an audible SASH open ALERT feature that can be implemented to caution users whenever the fume hood sash opening exceeds a predetermined amount. The audible alert shall consists of one minute repeating cycles of a series of quick 'chirps' that continues until the sash opening is reduced to an allowable amount. There shall be two sash alert opening settings, based on whether hood is in use or unattended.

g. The ODP shall provide audible and visual indication whenever supervisory signal is lost from a fume hood sash sensor or the flow input transmitter, by turning on the Red light and the audible alarm device.

h. The ODP shall be provided with an intuitive visual effect, such as a green “leaf” light, for indicating safe, sustainable operation, such as keeping sash closed when not in use.

5. All fume hood control and ODP display and operational parameters shall be established and be changeable only by authorized personnel using a portable operator's terminal. These operational parameters shall include:

a. Fume hood average face velocity setpoint.

b. Fume hood minimum & maximum exhaust airflow.

c. Face velocity high and low alarm limits and associated alarm time delay to avoid transient alarms.

d. Face velocity high and low warning limits.

~~e. Emergency purge time periods and exhaust levels.~~

~~f. Allowable maximum sash opening associated with the sash alert feature.~~

~~6. The portable operator's terminal shall plug into the ODP as well as into the laboratory room controller. In addition, all laboratory fume hood and laboratory room control parameters along with all other facility control and monitoring functions shall be accessible to authorized personnel from designated terminals on the BAS control and monitoring network.~~

~~7. Momentary or extended losses of power shall not change or affect any VAV fume hood control setpoints, operational parameters or stored data. Upon resumption of power after a power failure, fume hood controllers shall resume full normal operation exactly as before the power failure and without any need for manual intervention. Upon a power failure or operational failure within the fume hood controller, the fume hood exhaust air terminal shall be automatically positioned to the fully open (failsafe) position as required by laboratory safety standards and defined herein.~~

~~8. Coordinate sash sensor requirements with the fume hood size and sash configuration defined in the Lab Furnishings documents.~~ (Add.No.01)

~~G. 2-STATE (CV2) FUME HOOD CONTROLLERS~~ (Add.No.01)

~~1. Provide a UL 916 listed controller where shown on drawings for constant volume-2 state (CV2) fume hoods. Exhaust air shall be controlled at two individual setpoints corresponding to switch/software command as indicated in, Sequence of Controls. The exhaust control process shall maintain exhaust at its respective setpoint in response to actual exhaust airflow measurement to ensure full pressure independent closed loop control using a proportional, integral and derivative (PID) control algorithm.~~

~~2. Controller shall be capable of receiving status override functions as defined in, Sequence of Operation.~~

~~3. The controller shall provide a continuous signal to the Lab and Pressurized Room Controller indicating exhaust airflow to ensure stand-alone flow tracking. If the control function is directly connected to the Lab and Pressurized Room Controller, a dedicated controller is not required. Stand-alone controllers relying on the LAN or "assumed flows" for input to the Lab and Pressurized Room Controller are not acceptable.~~

~~4. Provide an Operator Display Panel (ODP) for local alarming as specified under Part 2 of this specification, if not provided by fume hood manufacturer.~~ (Add.No.01)

~~H.~~F. CONSTANT VOLUME ~~AND 2-STATE~~(Add.No.01) FUME HOOD MONITORS

1. General failure.

2. Exhaust flow.

3. Exhaust flow setpoints.

~~4. Occupied/unoccupied status~~Status~~.~~ (Add.No.01)

~~5. Occupied/unoccupied flow setpoints~~Flow Setpoints~~.~~ (Add.No.01)

~~6.~~4. Low and high flow warnings.

5. Low and high flow alarms.

~~7.~~6. Face velocity with local alarm. (Add.No.01)

~~I.~~G. CAV~~/2-STATE~~ (Add.No.01) AUXILLIARY EXHAUST DEVICE CONTROLLERS

1. Provide a UL 916 listed controller where shown on drawings for constant volume-2 state (CV2) auxiliary exhaust devices (i.e., canopy hoods, snorkels etc). Exhaust air shall be controlled at two individual setpoints corresponding to switch/software command as indicated in, Sequence of Operation. The exhaust control process shall maintain exhaust at its respective setpoint in response to actual exhaust airflow measurement to ensure full pressure independent closed loop control using a proportional, integral and derivative (PID) control algorithm.

2. Controller shall be capable of receiving status override functions as defined in, Sequence of Operation.

3. The controller shall provide a continuous hardwired flow signal to the Lab and Pressurized Room Controller indicating exhaust airflow to ensure stand-alone flow tracking. If the control function is directly connected to the Lab and Pressurized Room Controller, a dedicated controller is not required. Stand-alone controllers relying on the LAN or “assumed flows” for input to the Lab and Pressurized Room Controller are not acceptable.

~~J.~~H. BIOSAFETY CABINET (DUCTED) EXHAUST FLOW CONTROLLER

1. Provide a UL 916 listed controller where shown on drawings for ducted Biosafety Cabinets (BSC). Exhaust air shall be controlled as indicated in, Sequence of Operation. The exhaust control process shall maintain exhaust at its respective setpoint in response to actual exhaust airflow measurement to ensure full pressure independent closed loop control using a proportional, integral and derivative (PID) control algorithm.

2. Controller shall be capable of receiving any status override functions as defined in, Sequence of Operations.

3. The controller shall provide a continuous hardwired flow signal to the Lab and Pressurized Room Controller indicating exhaust airflow to ensure stand-alone flow tracking. If the control function is directly connected to the Biosafety Lab and Pressurized Room Controller, a dedicated controller is not required. Stand-alone controllers relying on the LAN or “assumed flows” for input to the Lab and Pressurized Room Controller are not acceptable.

~~K.~~I. Terminal Unit Space Temperature Sensor

1. Each controller performing space temperature control shall be provided with a matching room temperature sensor.

2. Basis of Design – Siemens QAA 2200 Series

3. Plain Space Temperature Sensors – Where called for in the sequences or on the drawings, provide sensors with plain covers.

   a. The sensing element for the space temperature sensor shall be 10k ohm type 2 thermistor and provide the following:

      1) Element Accuracy: + /- 0.9°F

      2) Operating Range: 55 to 95°F

      3) Installation: Up to 100 ft. from controller

   b. Auxiliary Communication Port. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. RS-232 communications port shall allow the operator to query and modify operating parameters of the local room terminal unit from the portable operator’s terminal.

4. Digital Display temperature sensor specifications

   a. As called for in the sequences of operations or on the drawings, provide temperature sensors with digital displays.

   b. The sensing element for the space temperature sensor must be IC-based and provide the following.

      1) Digitally communicating with the Application Specific Controller for providing consistency of measurement reporting, more accurate measurement, and faster updates to controller. The device shall be provided with a single sensing element for reporting the same value to both the local room unit display and the Application Specific Controller.

      2) Mountable to and fully covering a 2 x 4 electrical junction box without the need for an adapter wall plate.

      3) IC Element Accuracy: +/- 0.9°F .

      4) Operating Range: 55 to 95°F (13-35°C).

      5) Device shall allow display in either degrees F or C.

      6) Display of temperature setpoint with numerical temperature.

      7) Installation: Up to 100 ft. from controller.

      8) Local OLED Temperature Display: Included.

9) Display of Temperature to one decimal place.

c. Auxiliary Communication Port. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. RS-232 communications port shall allow the operator to query and modify operating parameters of the local room terminal unit from the portable operator's terminal.

5. Options: Provide the following options as they are called for in the sequences or on the drawings:

a. Setpoint Adjustment. The setpoint adjustment function shall allow for modification of the temperature by the building operators. Adjustment range shall be a user limiting, selectable range between 55 and 95°F (13-35°C) , Setpoint adjustment may be locked out, overridden, or limited as to time or temperature through software by an authorized operator at any central workstation, Building Controller, room sensor two-line display, or via the portable operator's terminal.

b. Devices with display and setpoint adjustment shall be provided with calibration capability allowing the displayed and communicated value to be biased to +/- 5°F of the temperature reading, for reconciling measurement accuracy to a calibrated handheld device.

c. Devices with display and setpoint adjustment can display setpoint either as a numerical value or as a relative setting (colder or hotter), based on setpoint range.

d. Override Switch. An override button shall initiate override of the night setback mode to normal (day) operation when activated by the occupant and enabled by building operators. The override shall be limited to two (2) hours (adjustable.) The override function may be locked out, overridden, or limited through software by an authorized operator at the operator interface, Building Controller, room sensor two-line display or via the portable operator's terminal.

e. Space Combination Temperature and Humidity Sensors.

1) Basis of design – Siemens QFA 3280 Series

2) Each controller performing space temperature control shall be provided with a matching room temperature sensor, which also includes the ability to measure humidity for either monitoring or control purposes. The combination temperature and humidity sensors shall have the same appearance as the space temperature sensors. Humidity elements shall measure relative humidity with a +/- 2% accuracy over the range of 10 to 90% relative humidity. Humidity element shall be an IC (integrated circuit) sensing element. Humidity sensing elements shall be removable and field replaceable if needed.

2.7 HUMIDITY SENSORS

A. Basis of design: Siemens QFA/QFM Series.

B. Room Relative Humidity (QFA Series):

1. Sensor Humidity range 0 to 100%.

2. Accuracy +/-2% rh (10-90% rh).

3. Sensing element Digital Sensor IC (capacitive).

4. Output signal 4-20 mA/0-5V/0-10V selectable.

5. Calibration adjustment adjustable to +/-5% rh.

C. Duct Relative Humidity (QFM Series):

1. Sensor Humidity range 0 to 100%

2. Accuracy +/-2% or +/- 5% as indicated in the sequences or drawings.

3. Sensing element Digital Sensor IC (capacitive).

4. Output signal 4-20 mA/0-5V/0-10V selectable.

5. Calibration adjustment adjustable to +/-5% rh.

D. Humidity sensing elements shall be removable and field replaceable if needed.

E. Provide with readable LCD display where indicated in the sequences or drawings

F. Room Sensors: For rooms with temperature sensing as well, provide a combined temperature/humidity sensor or provide units with matching cover. Provide options as required by sequences or drawings and specified under Terminal Unit Space Temperature Sensor “Options”.

G. Provide certificate of calibration where called for in sequences or drawings

2.8 OCCUPANCY SENSORS

A. Occupancy sensors shall use a combination Passive Infrared (PIR) and Microwave technology with continuous monitoring and built-in diagnostics. Ceiling mounted units shall have 360 deg field-of-views.

B. Basis of design: IntelliSense DT-6360STC.

2.9 ROOM PRESSURE SENSORS

A. Basis of design: Setra Model 264.

B. Ultra low differential pressure transmitter with the following minimum characteristics:

1. Pressure Range +/- 1.0 inches w.c.

2. Accuracy +/- 0.25% of Full Scale Range.

2.10 ROOM PRESSURE, TEMPERATURE AND HUMIDITY MONITORS

A. Basis of design: Siemens Model SRCM.

B. Provide an integral very low differential pressure transmitter and monitor connected to passive pressure probes located in each space indicated on drawings. Monitor shall have the option of using a remote pressure transmitter in lieu of the integral transmitter or in addition to the integral transmitter for indicating differential pressure from a second space (eg, space plus anteroom).

C. Monitor shall be provided with a backlit LCD display to indicate pressure difference between the space and reference space, with polarity indicating positive or negative to the reference space. The display shall also have status indicators for Normal (Green) and Alarm (Red) conditions and audible alarm (with time delay feature). Monitor shall be provided with digital readout of differential pressure and bar graph indicating range. Monitor shall have the capability of “cloning” configurations to simplify the set up of multiple unit installation.

D. Display shall be capable of monitoring a primary and secondary room, with free form data entry for room names. Conditions available for both rooms shall be pressure, temperature and humidity and a user defined parameter. Engineering units shall be field selectable (inches WC/Pa; Fahrenheit/Celsius).

E. Monitor shall be provided with a password protected “Quick Room Change” feature, which allows the user to disable alarms temporarily.

F. Room Pressure Monitor shall have the following minimum characteristics:

1. Output signal: 0-5Vdc/0-10Vdc/4-20mA, field selectable.

2. Input signal: 2 inputs for remote pressure sensors; 1 internal pressure sensor.

3. Alarm output: SPDT relay.

4. Operating power: 24 VAC. 60 Hz.

5. Pressure Range: +/- 1.0 inches WC (or as indicated in sequence, drawings).

6. Accuracy: +/- 0.25% of Full Scale Range (or as indicated in sequence, drawings).

7. Resolution: 0.001 inches WC.

8. Door status: SPDT or SPST NO.

9. Pressure Fittings Barbed fittings for 1/4” O.D. tubing.

10. Communication to the BAS/room controller shall be via proprietary protocol or BACnet MS/TP ASC. For applications requiring pressure control, the output signal may be used in addition to digital communication – see sequences/drawings for requirements.

11. If required by sequence/drawings, interlock monitor with door contacts. If door input is enabled, monitor shall indicate open door via Yellow indication on display

12. If indicated on drawings/sequences, provide a remote annunciator where shown. Annunciator shall be provided with audible alarm and LEDs indicating Normal (Green) and Alarm (Red).

2.11 REPORTING REQUIREMENTS

A. Performance Reporting

1. System shall be capable of providing the following information as part of Continuous Commissioning and ongoing Measurement and Verification and in support of a Health and Safety Management System. Reporting shall be offered as part of a service agreement.

2. Performance data shall be continuously collected from the BAS system to verify performance and diagnose operating issues of the laboratory ventilation control system. Various performance metrics may be used as appropriate. These metrics shall include:

   a. Supply and Exhaust air volume

   b. Temperature

   c. Humidity (if measured as part of this project)

   d. Room volume difference

   e. Room directional air flow

   f. Room ventilation rate

   g. Fume hood exhaust air volume

   h. Fume hood sash position

   i. Fume hood minimum flow

   j. All air volume set points and alarms or other appropriate metrics selected by the owner or owner’s representative.

3. Laboratory performance data shall be reported by groups and for individual laboratories and equipment. Groupings shall be by facility, building wing, building section, building floor, department and room as determined by the owner or owner’s representative. Reports shall have daily, weekly, monthly or annually selectable time periods. Report data intervals shall be 15, 30 or 60 minute.

4. Laboratory performance data trend interval shall be 5 or 15 minutes as appropriate for the intended use of the specific information collected.

5. Reports and performance data shall be available through a web based server. Web based performance reporting shall include standard tabular reports described above. Reporting shall also include graphical based reporting for room and fume hood performance data. Charts shall be available in 15, 30 or 60 minute intervals as well as daily and weekly. Charts shall support multiple data points selected by the user. Data export capability shall also be included.

6. Reports of laboratory room and fume hood performance shall be prepared and reviewed with the owner monthly, quarterly, semi-annually or annually as determined by the owner or owner's representative as part of the service agreement. Standard reports shall be available illustrating summary and detail laboratory room performance; summary and detail fume hood performance, sash management effectiveness, and energy consumption comparison to the energy use baseline.

2.12 MOBILE APPLICATIONS

A. iPad Application

1. Basis of design: Siemens Facility Prime

2. Provide an iPad and native iPad iOS application to directly communicate with BACnet/IP and/or Siemens APOGEE P2 Ethernet field panels. Software connection through a web browser is not acceptable.

3. IPad/application shall connect to the BAS via the site's WiFi (802.11 a/b/g/n) network or remote cellular connection via the customer's VPN access.

4. The application shall have the following capabilities as a minimum

   a. Graphical view of real time environmental conditions and linked HVAC equipment

   b. Graphical animation by displaying different image files for changed object status

   c. "View only" capability requiring no logon once application has been opened.

   d. Application can stay open and active without user interaction or time-out.

   e. A reporting function must capture current information shown on the graphical view and save the image as a PDF file and/or attach it to an email.

f. After proper access credentials are authenticated, a user can command points (e.g. data values and device settings) and equipment. Commands must be able to be logged within the BAS

g. Users must be able to navigate the graphics using custom links, from a menu list, or by scanning QR codes.

h. Alarm Indication and Acknowledgment – must allow for display of points in alarm, both unacknowledged and acknowledged. Acknowledgement of alarm conditions from within the application is required.

5. Editing tool must be available within the application to create and manage graphics. Tool must include the following:

a. Graphical elements library including gauges, sensors, trends, point blocks, command buttons, embedded documents, and imported images.

b. Ability to import documents, photos, and images to be used in graphics.

c. Ability to link elements to graphics by entering point address information or by utilizing browser and auto-discover sequences.

d. Capability to transfer graphics to other iPads

6. Site Wi-Fi© (802.11 a/b/g/n) network shall be provided/managed by the Owner.

7. Contractor shall coordinate with Owner to purchase and load application onto iPad via Owner designated iTunes account per Apple© Terms and Conditions.

8. Contractor shall spend three days with Owner to assist with initial setup, provide initial graphics/monitoring/control functions, and training on all aspects of the application

9. Contractor shall carry the cost of the application, an iPad (wi-fi + cellular) and any interface devices required to communicate with the BAS

10. Cellular data plan shall be provided by Owner as needed

PART 3 - EXECUTION

3.1 INSTALLATION

A. The ACS/BAS supplier shall install all control system equipment including controllers, sensors, damper actuators, reheat valves, fume hood sash sensors and fume hood operator display panels. This contractor shall install and terminate all low voltage control system wiring including wiring between each controller and between each controller and all control and sensing devices. This contractor shall also provide 24 VAC power where required by the control system and associated control devices. This contractor shall install pneumatic

control tubing from the nearest building air main for all control devices that are pneumatically operated.

B. The electrical contractor shall provide 120 volt power in the laboratory ceiling spaces for connection to the laboratory control system equipment.

C. The mechanical contractor shall install all supply air terminals, reheat coils, exhaust air terminals, air valves and interconnecting ductwork associated with the laboratory ventilation system;

D. Air Terminal, Reheat Coils and Control Valves:

1. ACS/BAS contractor shall furnish to Mechanical Contractor for installation air terminals, sound attenuators, reheat coils and access doors as shown on drawings and according to manufacturer’s instructions. Mechanical Contractor shall install reheat coils control valves furnished by BAS contractor, and shall provide necessary ductwork transitions as required for mounting equipment provided by ACS/BAS contractor.

2. Mount actuators on same side of air terminal device as coil connections to ensure service access.

3. Connect air terminals to ductwork with removable type joints as detailed.

4. Transition from supply air terminal to reheat coil shall not exceed 15° per side.

5. Provide access doors for supply air terminals with reheat coils. Mount access door at inlet side of coil. Refer to Section 23 3314 - Ductwork Specialties for access door requirements.

E. Fume Hood Controls:

1. Furnish to fume hood manufacturer templates for required hood mounted devices including vertical and horizontal sash sensors, interface boxes, and fume hood monitors required for complete installation of fume hood exhaust air control system. Fume hood manufacturer shall provide necessary cut outs with blank cover plates.

2. Fume hood size and sash configuration are called out in Lab Furnishings documents. Verify with fume hood manufacturer fume hood sizes, sash configurations and installation requirements for each device.

3. ACS/BAS manufacturer shall field install, mount and wire required hood mounted devices.

F. Control and Power Wiring:

1. ACS/BAS manufacturer shall provide control wiring from laboratory control panel to and between other laboratory control system components as required for complete and proper functioning,

including but not limited to air terminals, control valves, sensors, transducers, controllers, panels, and interface modules.

2. Electrical Contractor will provide one spare 20-amp circuit at each emergency power electrical panel, serving laboratory. ACS/BAS supplier shall provide required conduit, wire, junction boxes, disconnect switches and circuit breakers as specified in Division 26 as required to wire electrical panel to each laboratory control panel.

G. Laboratory/Pressurized Space Control Panels and Power Supplies:

1. Mount laboratory and pressurized space control panels and power supplies in accessible location within laboratory room as shown on plans.

2. Coordinate location of electrical power panels with Division 26 Contractor.

3.2 CHECKOUT AND TESTING

A. Coordinate timing of start-up with Mechanical Contractor to confirm HVAC Systems are operating as specified.

B. System startup shall be provided by factory authorized representative of system manufacturer. All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner’s representative is notified of the system demonstration. Start-up shall include the following tasks:

1. Determine when the HVAC equipment and each room are ready for ventilation system operational testing.

2. Furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.

3. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.

4. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules.

5. Alarms and Interlocks:

a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.

b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.

c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

6. Set up all room and specialty exhaust controllers and verify that all controlled parameters are being maintained at the required setpoint and that all associated operational aspects including measurement accuracies, alarm criteria, high-low limits, time delays, etc. are functioning in accord with the specified performance. The Testing Adjusting and Balancing (TAB) agent shall verify that all airflows are within the specified requirements and any departure from the specified performance shall be corrected and verified by the ACS/BAS to ensure all aspects of the control system are in full conformance with these specifications. The setup and verification process shall cover as a minimum:

   a. Fume hood face velocity and/or fume hood exhaust airflow rate control.

   b. Fume hood high and low alarms.

   c. Room supply and exhaust airflows and the room ventilation rate control.

   d. Room static pressurization control and associated operational criteria.

   e. Room ambient temperature control.

   f. Room/zone humidity control.

   g. Room emergency control sequences.

   h. Pressurized space centralized exhaust system static pressure, exhaust stack velocity and associated exhaust system functionality.

C. All operational aspects of the ACS/BAS performance shall be formally recorded when verified and a copy of the recorded data shall be provided to the owner as part of the as-built documentation

3.3 SYSTEM DEMONSTRATION

A. Demonstration:

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.

2. The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the “Checkout and Testing” article in Part 3 of this specification. The engineer will be present to observe and review these tests. The

engineer shall be notified at least 10 days in advance of the start of the testing procedures.

3. The demonstration process shall follow that approved in Part 1, “Submittals.” The approved checklists and forms shall be completed for all systems as part of the demonstration.

4. The ACS/BAS supplier shall provide a functional demonstration on the ACS/BAS operation to owner designated representatives as well as other interested participants which may include the architect, engineer, as well as the general and mechanical contractors. This demonstration shall include any ACS/BAS control sequences selected by the owners representatives and may cover several laboratory rooms.

5. ACS/BAS manufacturer shall provide a visual demonstration that the laboratory airflow systems are maintaining specified hood containment performance requirements. This demonstration shall be performed on 10% of the hoods. Coordinate with and work in conjunction with TAB Contractor.

6. ACS/BAS manufacturer shall demonstrate that, with specified room offset, system maintains proper room directional air flows under both static and dynamic operating conditions, and can recover to proper flow direction upon change in room/system conditions such as raising and lowering of any hood sashes or room occupancy conditions, temporary deficit of exhaust system capacity. Verification shall be provided by temporary visual indication, such as smoke wand. Coordinate with and work in conjunction with TAB Contractor.

7. Demonstration shall also include (but not limited to) exhaust system functionality, emergency functions and associated local monitoring provisions as well as required BAS monitoring and alarm reporting.

8. The day for this demonstration shall be established by the owner’s representatives in conjunction with the other participants.

B. Acceptance:

1. All tests described in this specification shall have been performed to the satisfaction of both the engineer and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the engineer. Such tests shall then be performed as part of the warranty.

2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, “Submittals.”

3.4 TRAINING

A. The ACS/BAS system contractor shall provide on-site instruction for up to six (6) owner designated personnel covering all aspects of the operation and use of the ACS/BAS including operator interface, control parameter setpoint adjustment, alarm limit and time delay adjustments, point trending, automatic startup, shutdown and changeover scheduling as well as the manipulation and utilization of all associated ACS/BAS monitoring and control functions. The training shall be augmented an operational manual for each attendee and shall also include the recommended procedures to verify the proper functioning of the ACS/BAS. Instructors shall be highly qualified factory trained personnel who reside at the local branch office of the ACS/BAS supplier and who are thoroughly familiar with all aspects of the overall subject matter and this specific facility's ACS/BAS. All training shall be provided on weekdays during the normal daytime working hours of the facility operations personnel.

B. Training shall consist of not less than 24 hours for designated personnel and shall include:

1. A thorough walk-through of the facility to identify ACS/BAS controls and controlled equipment.

2. Explanations of the ACS/BAS system, its operation and user interaction.

3. Explanation of laboratory room and fume hood control sequences.

4. Explanation of adjustment, inspection and test procedures.

C. Additional specialized operational training courses shall be made available to facility personnel covering the ACS/BAS and its components

3.5 INSPECTION, TESTING AND PREVENTIVE MAINTENANCE

A. To ensure system operational reliability, control systems that do not incorporate independent airflow measurement as required for true closed loop control shall include a two (2) year inspection, testing and preventive maintenance program on the overall ACS/BAS and its components after the initial warranty period has expired. This additional inspection, testing and preventive maintenance program shall be at no additional cost to the owner and shall require the ACS/BAS supplier to include two thorough annual inspections of all airflow control devices, actuators and associated internal and external linkages. As a part of this program all airflow control device linkages shall be cleaned to avoid fouling and to ensure proper continued operation. Any airflow control device and/or linkage that cannot be restored to normal to its initial non-contaminated condition shall be replaced at no cost to the owner. The owner shall have the option of including designated facility personnel to accompany the supplier's personnel who are performing these procedures in order to ensure that no control system devices are overlooked and to acquire firsthand knowledge on how to perform the annual inspection, testing and preventive maintenance procedures.

B. Systems that incorporate true closed loop control by independent airflow measurement shall offer an annual inspection, testing and preventative maintenance program as an option to the owner.

3.6 BUILDING AUTOMATION SYSTEM INTERFACE

A. Where applicable the following laboratory ventilation and environmental information shall be provided to the BAS:

1. Fume hood average face velocity (fpm) or (m/s) and high / low alarm.

2. Fume hood open face area (sq. ft.) or (sq. m).

3. Fume hood exhaust airflow (cfm) or (l/s) and high / low alarm.

4. Laboratory room supply minimum airflow limits (cfm) or (l/s) and high / low alarm.

5. Laboratory room. supply maximum airflow limits (cfm) or (l/s) and high / low alarm

6. Laboratory room general exhaust minimum airflow limits (cfm) or (l/s) and high / low alarm.

7. Laboratory room general exhaust maximum airflow limits (cfm) or (l/s) and high / low alarm.

8. Laboratory supply air temperature (0F) or (0C).

9. Laboratory room ambient temperature (0F) or (0C) and high / low alarm.

10. Laboratory room humidity (%RH) and high / low alarm.

11. Laboratory room differential airflow (cfm) or (l/s).

12. Laboratory room differential pressure (In. W.C.) or (Pa) and high / low alarm.

13. Exhaust system static pressure (In W.C.) or (Pa) and high / low alarm.

14. Exhaust system fan status, damper position, and associated alarm parameters.

15. Exhaust system stack velocity (fpm) or (m/s).

16. Wind speed (mph) or (km/h) and direction.

B. Information may be communicated by means of protocol translators or by seamless LAN connections. As an option the ACS/BAS supplier may provide the information by individual direct connections (hard wired inputs). If the direct connection approach is used the ACS/BAS supplier shall be responsible for all interconnecting wiring and any additional BAS and ACS/BAS system control panels that may be required to accept these inputs. If the communications approach is used the

ACS/BAS supplier shall be responsible for all network wiring and any protocol translators required by the BAS and ACS/BAS.

C. The ACS/BAS system shall accept the following control inputs from the BAS:

1. Room airflow tracking offset setpoint adjustment.

2. Room ambient temperature / humidity setpoint adjustment.

3. Occupied/Unoccupied state of the room for room control mode changeover

4. Exhaust Minimum and Maximum flow limits

5. Supply Minimum and Maximum flow limits

3.7 CONTROL SEQUENCES OF OPERATION AND ALARM LIMITS

A. Refer to points list for alarm points. Alarm points and appropriate message to be segregated and classified to complement facility protocols and procedures.

B. Refer to Control Sequences

1.8 CONSTRUCTION WASTE MANAGEMENT

A. General: Comply with Contractor's Waste Management Plan and Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.

B. To the greatest extent possible, separate reusable and recyclable products from contaminated waste and debris in accordance with the Contractor’s Waste Management Plan. Place recyclable and reusable products in designated containers and protect from moisture and contamination.

1.9 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

- - - E N D - - -